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grees 55 minutes, Washington is admirably situated for making observations intended to supplement the work of the European observatories and at the same time that of the observatories of the southern hemisphere. It is twelve and one half degrees south of Greenwich, twenty degrees south of Pulkowa and seven and one half degrees south of the new branch of the Pulkowa Observatory at Odessa. Stars of thirty degrees south declination are observed on the meridian at Washington at an altitude of twenty-one degrees and very near the zenith at Cordoba and the Cape of Good Hope. Being ten to fifteen degrees south of the observatories of central Europe, and yet far enough north for accurate observation of the circumpolar stars, perhaps no location better in this respect could be found for extending the accurate star places of the northern hemisphere thirty degrees or more south of the equator for comparison with the results of observations made in the southern hemisphere.

The value of the great work on the positions of the stars which has been carried on at Greenwich during the two hundred years which have elapsed since Flamsteed's time is recognized by every astronomer. As an example of continuous activity directed toward a definite end it is perhaps without a parallel in the history of science. Until 1850 a transit instrument of five inches aperture and a mural circle six feet in diameter, both by Troughton, were used. In that year the present Greenwich transit circle of eight inches aperture and twelve feet focal length was mounted by Airy. The axis is six feet long and the divided circle is six feet in diameter. While one of the most powerful instruments of its kind in the world, its construction is such as to make it liable to systematic error. No meridian mark is provided, although the north collimator was at one time used as such, and the spirit level is not used. Fur-

thermore, the instrument cannot be reversed.

The great value of the fundamental work which the Pulkowa Observatory has done during the past sixty years is generally recognized. The instruments used have been of the best quality and their construction has been improved from time to time. The methods of observation are of the highest class and the systematic errors of the results have been found to be very small. But at the extreme north latitude of Pulkowa, the altitude of the sun on the meridian at the winter solstice is only seven degrees, and stars at the celestial equator are observed at an altitude of only thirty degrees. As a consequence the best work of that observatory is limited to stars of north declination. With the good judgment and enterprise which have from the first characterized the management of the Pulkowa Observatory, the branch observatory, mentioned above, was established in 1898 at Odessa, thirteen degrees further south, where valuable work is no doubt being done.

But all instruments and all methods of observing have their peculiar forms of error, and it seems clear that the establishment of a third center in the northern hemisphere for continuous fundamental observations of the stars is very desirable.

MILTON UPDEGRAFF.

U. S. NAVAL OBSERVATORY,
WASHINGTON, D. C.,
June 15, 1902.

THE CARNEGIE INSTITUTION.

THE provision for research constitutes a supremely important part of the intellectual organization of a great nation. A profound recognition of this fact has brought into existence the Carnegie Institution. I have elsewhere recorded (*The Dial*, February 16, 1902) my appreciation of the general aims and purposes of this

notable foundation. The immediate problem, to which the editor of *SCIENCE* invites attention, is the inauguration of measures that shall most effectively aid the cause of original investigation; that shall relieve such obstacles as now beset the free development of the spirit of research in our midst; that shall encourage and promote the realm of scientific discovery, and give to research as a profession the dignity, appreciation and outward marks of success to which, as a potent contributor to vital interests of our civilization, it is unquestionably entitled.

It would be unwise for everyone whose concern in this problem is deep enough to induce him to give expression to it, to suggest ways and means of spending the income of ten millions of dollars. From what I have been permitted to learn of the intentions of the Carnegie authorities, I have inferred that they would regard as helpful, first, concrete suggestions as to the kind of expenditure which would do most for the cause of research, and the principles of inclusion and exclusion that shall be operative in determining the field of practical endeavor which the institution shall make its own; and, second, the suggestion of special researches for which funds are needed—which this or that individual is ready to undertake, and which an appropriate committee would be willing to endorse. The second portion of this program presents little that is novel; provisions for such endowment of research already exist, though to a very inadequate extent, and the Carnegie Institution will be able to offer more of such assistance and to maintain a directive oversight of such research in a far more comprehensive way than has been possible hitherto. The first part of the problem is at once more fundamental and more difficult; it requires a broad consideration of the actual conditions of research, of the relations of the

Carnegie Institution to the universities, to the governmental bureaus, to academies, to scientific associations, etc., as well as a consideration of the kind of encouragement which research requires, the deficiencies in the organization of research that demand correction, the direction in which future progress is to be shaped. It is to a few aspects of this problem that I shall address myself.

The direction in which, in my opinion, greatest utility lies is in the endowment of men rather than of projects. Hitherto in grants for research in America the emphasis has been decidedly in the opposite direction. There are, indeed, some grants to which a condition is attached that no part of the fund shall be used for personal expenses, nor for anything but apparatus and materials. The expert service involved, both of the investigator and of such assistance as he might require, must be freely offered. As a consequence, only those who have private means or who hold other positions yielding them alike sufficient income for a living and the requisite leisure for investigation, have been able to avail themselves of such aid. There will always be a number of persons of this class ready to engage in most desirable and important investigation, to whom substantial encouragement should be given; this is good as far as it goes, but it does not go far enough. If this were to be the sole or the chief function of the foundation, there would be a Carnegie Fund, but not a Carnegie Institution. There are many investigations that require not so much costly apparatus as extensive cooperation; the service of computers; clerical aid; opportunity for conference between leaders in related investigations; opportunities for travel and collection of material; and beyond all, leisure, release from instructional duties or other occupation necessary for gaining a livelihood. While research is an

avocation with many, it is a vocation with few; and the many pursue their investigations amid needlessly unfavorable conditions.

If this description of the status of affairs is approximately correct, the remedy would seem to lie in the direct endowment of men. If we have men who are precisely fitted by training, bent, devotion and ability for the work of research, why not provide the means for their support and leave them financially free, at all events, to devote their energies in the direction in which they promise greatest success? Undoubtedly they will require materials and apparatus—in some cases a most expensive equipment—but in nearly all cases they will first and foremost require a secure living and leisure. The elevation of the career of the devotee to research to a worthy professional standing would seem to be the special function which the Carnegie Institution can serve in behalf of learning in America.

In pursuance of such a policy there would be at once recognized the danger of interfering with the growth of the provisions for research now established or likely to be established at the universities. Such a possibility must be carefully guarded against. If it were to become the vogue for the university authorities, when the question of provision for research came up for discussion, to transfer such responsibility to the Carnegie Institution, quite as much harm as good would be done. The various ways in which the spirit of research is not only helpful but vital to the flourishing of true university work have been repeatedly and ably set forth; it will continue to require zealous protection until it becomes firmly established as an integral factor of our educational system. As a means of fostering the cause of research without needlessly releasing the universities from their true responsibilities, the suggestion is near at hand that the Car-

negie funds shall, here and there, be used to pay a portion of the salary or supplement the salary of this professor or that, on condition that he be relieved from all but a minimum of teaching, and thus be able to devote much of his energies to special research. An arrangement effecting substantially the same result exists in the case of geologists who hold an academic and a governmental position, and are able to minimize the instructional obligations of the former, while utilizing to the full the research facilities of the latter position. The university funds thus released would naturally be used for the engagement of an assistant, upon whom would fall the instructional and other work so frequently the serious obstacles to successful investigation. I do not advocate, except in special cases, the complete separation of instruction and investigation; on the contrary, I am convinced that each is helpful to the other, and that even the synoptic survey of one's science which an introductory course makes necessary is a useful task for the professor occasionally to assume, while the opportunity to serve as a leader to able young men is both stimulating and profitable. It is only to the extent that instructional and administrative routine interfere with the scholar's advancement along the lines of his special fitness, that provision should be made to prevent the sacrifice of the latter for the former.

In this connection a reference seems permissible to the special conditions under which the professor (for we may assume that in this country the typical man of research is a professor) must live and work. He is not independent; he is not free to follow his own inclinations; he has prescribed and absorbing duties. As with most men his income conditions his activity. He must first do that which is necessary to gain a living for himself and family, and to occupy that place in society which his

position makes proper. To accomplish this, an undue amount of care and effort is now expended; many a professor would have pursued a career of research had the necessity not been presented to him of increasing his income, owing to the insufficiency of his salary. With a larger salary, he would have felt free to engage such clerical assistance as was needed to release his own time, he would have refused offers of publishers to write text-books, of editors to prepare articles, would have provided himself liberally with books and the tools of his trade, and lived a life of greater approximation to his ideals than proved to be possible. Considered merely from a practical point of view, I have no doubt that the employment of a secretary in one case, of a laboratory assistant in another, of an increase in salary for household expenses in a third case, would really prove to be the most efficient, though indirect, aid to research. For when reduced to the lowest terms, the factors of which successful research is a function are these: the capacity for it, the material equipment, the time and energy. Assuming the first, and recognizing the various efforts which our educational institutions are putting forth to develop it, we have acknowledged the decided aid that comes from the provision of the second, and yet place the greater emphasis upon those measures which, with discernment and adaptation to actual conditions, make possible the enthusiastic devotion of time and energy to the field of research. As a fourth factor should be added the honors and attractions of the investigator's career, and the consequent inducement for the ablest young men to follow such a career. That the Carnegie Institution has the possibility of doing much in this last direction I have already maintained.

In other words, it is my conviction that the most serious obstacle to the proper

development of original research in America lies in the circumstance that those with greatest capacity for it do not make strenuous efforts to secure the material equipment they require (in so far as they do require it), because of the fundamental difficulty that the time and energy they have to give to the work are inadequate. The primary remedial measure must accordingly be the readjustment of their personal status, which shall make it unnecessary for them for the sake of income to devote their energies to other pursuits. In so far as such other pursuits are directly helpful to the intellectual career of the investigator, they should unquestionably be maintained; in so far as they contribute little or nothing to his investigating efficiency, they should be transferred to others, who, though occupying an equally important position in the educational world, find their greatest sphere of usefulness in another field. There is no implied disparagement of the professor's career as a teacher; that phase of his activity is for the present not under discussion. We are discussing the career of the investigator, and believe that the university furnishes an admirably suitable atmosphere for his development; and that it is very fortunate for the university to have among its members a considerable group who are primarily investigators. One of the principles of modern organization by which the services of individuals of decided ability are distributed as comprehensively as possible is that the director shall not do that which any of his assistants can do as well. This is the true economy of time and energy. My plea is for the more adequate extension of the same principle to the academic life; it is on account of the lack of proper assistants, and of a lack of a proper income to employ them, that the energies of some of our ablest men in the higher educational institutions are not utilized to the best ad-

vantage, are, indeed, in extreme instances, shamefully wasted.

Having ventured so far in the presentation of this point of view, I shall venture farther to defend it against one form of objection to which, in the opinion of some, it seems to lie open. We are told that a fellowship may degenerate into a form of almsgiving, that men need not be paid to study or to investigate, that grants to individuals smack of paternalism, and so on. To my thinking these positions are entirely false; and when a college president maintains that 'great gifts to education have been for the purpose not of feeding men but of furnishing means of study and investigation beyond the reach of individual effort,' he expresses a strangely perverse view of the situation. If we can only feed the right man—to hold for the moment to this needlessly brusque form of statement—we cannot perform a more notable service than by thus supplying at least one of the conditions for a career of greatest potential value to the nation. In one sense the greater portion of all educational endowments goes towards the maintenance of men. Fortunate, indeed, is the state of affairs that in some cases makes such endowment unnecessary. In reading the history of science in England one is repeatedly thankful that this man and that were so situated financially that they could devote their whole time and energy towards contributing to the world's knowledge. As we read the life of Huxley we share with him the feeling of relief when a comfortable living was at length assured him. It will hardly do to say that the true investigator will come to the front and create the conditions needed for his work despite all personal hardships and deprivations. The question is always painfully apropos: Where are the ships of those who were not saved and whose gratitude is not recorded by the models suspended from the church

beams? The cases of successful achievement despite inadequate facilities and encouragement should never be forgotten; but the great unknown mass of possibilities that lie buried beneath the waves of adversity likewise tell to the imaginative a suggestive story.

From the initial encouragement of a fellowship up to the highest honors of the scientist's career there should be rewards and appreciations, equal at least to those that invite men of exceptional talent in comparable spheres of intellectual activity. When the editor of *SCIENCE* tells us that 'the greatest obstacle to the advancement of science is, in my opinion, the circumstance that scientific men are not directly rewarded for their investigations and discoveries,' he is not implying any special lack of altruistic sentiment on the part of men of science; he is forcibly pointing out the essential disparity between the attraction to men of rare powers of the scientific and of comparable careers.

I have not left myself space to speak of other practical suggestions deducible in conformity with my main thesis. This is, perhaps, the less necessary, as the editor of *SCIENCE* has already indicated some of them. The establishment of at least a few notable prizes and of supplementary and adequate salaries for the encouragement of research are more ambitious but equally logical deductions from the principle of the direct endowment of men. The establishment of research fellowships is another. The creation of a board of managers for the institution, membership in which shall constitute a great honor and be suitably rewarded, is again in conformity with this view. It would be a great aid to the status of the university professor if there were some great prizes in the educational world outside of the administrative field. As it is, the college presidencies offer the most attractive incomes to men seeking the edu-

cational career. This is doubly unfortunate, as it has served to overvalue the particular grade of ability which such work demands, and to undervalue the intrinsically superior capacity needed for eminent success in the field of investigation.

I have likewise omitted direct reference to the question of a distinctive Carnegie Institution at Washington. I have made it clear that such an institution is indispensable to the realization of the larger national place for research which I have advocated. It is because I feel that the immediate danger is that the Carnegie Institution may become a great subsidiary agency and nothing more, that I have selected the opposition to that plan for my major thesis.

To bring my plea to a focus, let me attempt to repeat briefly the points of emphasis:

1. That the Carnegie funds shall be devoted primarily to the endowment of men; without neglect of the fact that many projects demanding cooperative* energy and special equipment are worthy of encouragement.

2. That the Carnegie Institution shall distinctly supplement and in no way diminish or discourage or absorb the existing provisions for research.

3. That the path of endeavor and plans for the inauguration of progressive measures be determined by an inquiry in regard to the obstacles and difficulties that now beset the career of the investigator and be

* I have omitted for lack of space any concrete illustrations of the cooperative or centralizing functions which the Carnegie Institution might serve. A good instance would be found in the establishment of a central instrument works. Most professorial inventors carry their inventions up to the just-workable and barely-presentable stage. If at this point the apparatus could be sent to a central bureau where it would be technically perfected by mechanical specialists, reproduced and supplied to laboratories at cost of production, a very great boon would be offered to the devotees of almost all the sciences.

directed to the removal of those difficulties.

4. That the Carnegie Institution adopt as one of its peculiar missions the establishment both of general conditions and of special attractive rewards for the successful investigator and the encouragement of the man of promise, and in this and other ways place the career of the professional investigator upon a more secure and more honored footing than it now occupies.

JOSEPH JASTROW.

TO THE EDITOR OF SCIENCE: Referring to your interesting article on the Carnegie Institution, and responding to your request for suggestions as to how the fund might be utilized, I would respectfully submit that a portion of the income might well be made available to enable members of the faculties of the smaller, but poorly endowed, colleges to enjoy the advantages of a sabbatical year. Smaller colleges cannot, as a rule, afford to give their faculties this much-needed change, and the men cannot afford to spend the year without salary. In fact, they can hardly afford to take even a vacation trip to the great educational centers.

An arrangement might be feasible whereby a college would guarantee, say, one fourth of a man's salary, and the Carnegie Institution might guarantee one half, or better still, three fourths, on the condition that the year be spent in actual work at one of the well-equipped universities or in one of the government laboratories. If the man went abroad the condition should be made that his time should be spent in a country the language of which he understands.

By this plan, not only would many an underpaid and overworked college teacher, now isolated from proper library facilities and from contact with men in his own line

of study, be able to 'work up' interesting and valuable material collected during his isolation, but he would enjoy a much-needed and revivifying change of scene and association, and the advantages gained by him would be of direct value to his college, to his students, and to the general education of the country. At the same time, he could count upon fourteen months for research.

Should such a plan meet with approval, it would perhaps not be unreasonable to ask the prominent and more wealthy universities to establish free Carnegie fellowships, thus relieving the men in question from the payment of tuition, laboratory fees, etc.

CH. WARDELL STILES.
U. S. PUBLIC HEALTH AND MARINE-HOSPITAL SERVICE.

THERE are two points not yet brought out in the discussion: (1) The stamp of approval of the Carnegie Institution is likely to act as a patent of nobility and to make certain lines of research creditable, that is, acceptable to authorities who are influenced, not infrequently, by what 'is made in Germany.' (2) The most 'conspicuous waste' to-day is that of the man who *might be* the 'exceptional man' if he and his parents before him had lived up to the possibilities of perfect manhood which scientific knowledge now offers to those who value it enough to work as steadily to attain it as the business man does to gain the power to build a palace.

It is not enough to attain to great administrative ability, control over other men. The exceptional man now in demand is the one most ethically efficient as a man among men, as an exponent of what the human race is capable.

That is the kind of man it is the noblest privilege of mankind to study: that is the new humanities.

Two years of time in the secondary school and one year of time in college might be saved to at least one third the students in the country if they understood human œkology—the science of right living.

Dr. Sternberg's closing paragraph indicates one of the directions in which help must come, but there is needed a philosophical basis for the improvement of the race before the work will proceed far.

E. H. RICHARDS.
LABORATORY OF SANITARY CHEMISTRY,
MASS. INSTITUTE OF TECHNOLOGY.

IN response to an invitation from the editor of SCIENCE to express my views on the question how can the Carnegie Institution best advance science, I would repeat substantially the terms of the deed of trust: By sustaining original research, by upholding exceptional men, by increasing facilities for higher education, by cooperating with existing institutions, by promoting prompt publication; and *by doing all these things on a business basis*.

Though not expressed in the deed of trust, the last clause is sufficiently implied by the character of the donor, and it states a consideration which must control any action of the trustees. It is here emphasized because it serves to explain, to the writer at least, some of the differences of opinion which have recently been published.

To conduct research on a business basis is difficult, and, if the experience of the U. S. Geological Survey be a safe guide, requires the application of certain principles, which, though commonly recognized, have not always been applied in professional work. The first: Authority and responsibility are inseparable, is so familiar and fundamental as scarcely to need statement; but in practice it often requires subordination of one individual to another in a manner antagonistic to scientific inde-

pendence, and just consideration of the right to opinion leads to the conclusion that authority should be restricted to the domain of business and should not intrude in the realm of knowledge.

From this follows a distinction which may be stated as the second principle of an organization for research: Administrative control should be separate from scientific direction. The former then allots funds, supervises accounts, provides assistants and facilities, refers questions, gets out accepted results; in a phrase, its function is to run the machinery efficiently. Its control over and responsibility for moneys should be absolute. On the other hand, scientific direction consists in planning and approving plans, suggesting investigators, aiding them through broader knowledge, considering results and approving them for publication. Its control and responsibility are both partial and also widely variable, according to the relations existing between the director and the directed. In the Carnegie Institution this second principle appears to be recognized in the relation of an executive board and of a president who executes the purposes of that board to the several advisory committees composed of specialists in different branches of science.

In an organization thus built up of workers, advisers and administrators, co-operation becomes a vital principle to be not only accepted but cordially adopted and practiced. By cooperation in these relations I mean entering into one another's views and plans with an intelligent, sympathetic, though judicial understanding, with the one object of advancing the purpose of the organization. We may confidently hope that the Carnegie trustees and the scientists who are or may be associated with them will act with such breadth and liberality of opinion that cooperation will not fail.

Again, from the business point of view,

the trustees bear a heavy responsibility for the administration of the trust fund, and must necessarily view any proposition from a side other than that from which a scientist may regard it. In weighing the relative merits of the many demands which are being and will be made upon them, the members of the executive board must have ever in mind the purpose to promote science as distinguished from the opportunity to aid individuals or institutions. To the specialist who is ideally a man of single purpose their conclusion may not always seem obviously just, but it will be a safe basis of action. The case of the exceptional man who may be most liberally supported does not conflict with the general rule, since if he be the exceptional man—a Huxley, for example—his advancement is the advancement of knowledge.

I am indebted to the editor for opportunity to read in proof his own contribution to the discussion of the Carnegie Institution, but he covers much ground with which I am too little familiar to tread securely, and I regret that in those items where my opinion is based on experience in organization, I must differ from him. The Marine Biological Laboratory at Woods Hole, known for the high standard of its work, has a claim upon the interest even of those who, like myself, had no personal knowledge of its management, but the statement which admits the handicap of financial difficulties as a result of democratic organization is an indictment of that organization, and the fact that the members possessed high qualities of enthusiasm, devotion and capacity for self-sacrifice does not relieve the organized body of responsibility for inefficient administration if such there was; nor does that fact relieve the trustees of the Carnegie Institution of responsibility as trustees for the most efficient use of any fund they might allot to the work of the Laboratory. The as-

sumption that large expenditures for administration must follow from their management appears gratuitous, and the charge that they may crush out the public spirit of the Laboratory is not warranted by any facts made public.

A geophysical laboratory, as an object of investment on the part of the Carnegie Institution, does not commend itself to the judgment of the editor, but a laboratory for psychology does. Will I be understood if I plead inability to render an unbiased opinion in a case where my interests as a geologist are so nearly concerned?

The establishment of a board of managers consisting of twenty eminent scientists, as suggested by the Editor of SCIENCE, is a feature of a plan which perhaps should be discussed as a whole if at all; but with regard to such a board it may be suggested that it will in time develop, if it is needed, from the cooperative relations of the special scientific committees. And until the obvious need leads to evolution of additional organs, those which the Carnegie Institution now has may well be allowed to demonstrate their fitness to accomplish the ends of its generous founder.

BAILEY WILLIS.

LAMPASAS, TEXAS,
September 23, 1902.

SCIENTIFIC BOOKS.

Bibliography and Catalogue of the Fossil Vertebrata of North America. (To the end of the year 1900.) By OLIVER PERRY HAY. Bull. U. S. Geol. Surv., No. 179, pp. 868, 1902.

The present volume represents several years' diligent work on the part of a writer who has faced the hapless task of unraveling the literature of American fossil vertebrates. Of course such a task is by no means that of such a Hercules as C. Davies Sherborn, who is indexing no less than *all species of animals*; but I fancy it has been found tedious enough. It is missionary work certainly, and its author

deserves the gratitude of paleontologists, who would otherwise have had to have searched through 667 references for a species of Cope's, 225 for one of Marsh's, 221 for one of Leidy's. And the reviewer speaks feelingly, for he has occupied himself *en amateur* in a far smaller bibliographical study during the past half-dozen years, and can picture better than a layman the roomful of closely written cards which the author must have accumulated, and the mere physical labor of hunting up, handling and thumbing a mass of books which if put on a single shelf would extend over a mile. Dr. Hay has not merely ransacked libraries to complete the bibliographical writings of all authors who have meddled with American fossil vertebrates, but he has aimed to introduce a complete list of the anatomical and embryological references which bore upon the theme in hand. Then he has picked out the species and fitted them together in systematic arrangement, and finally made the names accessible by means of an elaborate index.

Before criticizing such a work as this, one must evidently bear in mind that absolute accuracy or completeness cannot be hoped for. Oversights, omissions and even proof errors are inevitable, and a fair critic, appreciating the volume's general tone of painstaking accuracy, cannot but feel that it deserves good wishes and scant blame. Its bad mistakes are rare, but minor omissions, points of disagreement and small errors are not uncommon. Its greatest defect is in the matter of cross-references to paleontology which occur in embryological and anatomical papers,—a defect which, however, would be naturally expected in a work of this kind. Its bibliographical lists, on the other hand, are generally accurate and well chosen, and are so complete indeed that one regrets that they are not perfect. Running over the names with which I am most familiar I find, for example, such omissions as these: *A. A. Wright*, a '97 *Dinichthys* paper; *Keyes*, Geology of Polk County ('97 Report of Iowa Geol. Survey); *Emerson*, Geology of Old Homestead County, Mass.; *Vaughan*, Geology of N. W. Louisiana; *Redlich*, on *Ptychodus*; *Seely*, on *Ceratodus*; *Dollo*, on *Lepidosteus*; *Leydig*, on *Koprolithen* u.